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SERIES SPECTRUM OF SODIUM, Na$_{II}$

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ABSTRACT

Seventy-four lines in the sodium spark spectrum are classified as combinations between twenty-three terms of Na$_{II}$. The ionization potential of Na$_{II}$ is fixed at 47.0 ± 0.5 volts.

THE spark spectrum of sodium has been obtained by Schillinger,[1] by Foote, Meggers and Mohler,[2] and more recently by Newman,[3] who also found a large number of constant frequency differences. It has now been

TABLE I. *Series lines in Na$_{II}$.*

Int.	λ (I. A.)	ν	Series Designation	Int.	λ (I. A.)	ν	Series Designation
2	372.04	268788.	$2p-3s_2$	4	3015.80	33149.1	$3p_8-X_7$
1	376.34	265717.	$2p-3s_4$	4	3029.56	32999.5	$3p_3-X_1$, $3p_8-X_8$
1	2506.27	39888.1	$3p_{10}-X_1$	4	3037.32	32914.2	$3p_8-X_9$
1	2515.57	39740.5	$3p_{10}-X_2$	3	3045.97	32820.8	$3p_4-X_3$
4	2531.64	39488.2	$3p_{10}-X_3$	5	3056.30	32709.9	$3s_5-3p_8$, $3s.-3p_5$
7	2612.10	38271.9	$3p_{10}-X_5$	1	3064.86	32618.4	$3p_7-X_7$
6	2661.65	37559.5	$3p_{10}-X_7$	1	3066.73	32598.6	$3p_2-X_1$
6	2671.90	37415.5	$3p_{10}-X_8$	5	3078.55	32473.4	$3s_4-3p_7$,$3p_7-X_8$
5	2678.25	37326.8	$3p_{10}-X_9$	1	3080.30	32455.0	$3p_2-X_2$
6	2809.73	35580.2	$3s_5-3p_2$	8	3092.98	32321.8	$3s_5-3p_9$
1	2818.58	35468.4	$3p_8-X_1$	3	3104.52	32201.8	$3p_2-X_3$
1	2830.01	35325.2	$3p_8-X_2$	0	3107.69	32168.9	$3p_3-X_4$
7	2841.99	35176.3	$3s_5-3p_3$	3	3124.64	31994.5	$3p_6-X_6$
3	2859.64	34959.2	$3s_5-3p_4$	7	3129.55	31944.3	$3s_4-3p_8$
0	2861.34	34938.4	$3p_7-X_1$	4	3135.69	31881.8	$3s_3-3p_7$
3	2871.53	34814.5	$3s_4-3p_2$	0	3146.05	31766.7	$3p_2-X_4$
0	2873.13	34795.1	$3p_7-X_2$	4	3149.51	31741.3	$3s_2-3p_2$
5	2881.38	34695.5	$3p_5-X_1$?	5	3164.16	31594.9	$3p_6-X_7$
3	2886.42	34634.9	$3p_8-X_4$	2	3179.29	31444.5	$3p_6-X_8$
4	2894.19	34541.9	$3p_7-X_3$	5	3190.05	31338.4	$3s_2-3p_3$
6	2905.11	34412.0	$3s_4-3p_3$	5	3212.44	31120.1	$3s_2-3p_4$
6	2917.78	34262.6	$3s_5-3p_6$	0	3216.60	31079.8	$3p_3-X_6$
5	2919.34	34244.3	$3p_9-X_5$	2	3226.16	30987.7	$3p_2-X_5$
4	2921.14	34222.9	$3s_3-3p_2$	3	3235.07	30902.4	$3p_4-X_7$
2	2923.67	34193.6	$3s_4-3p_4$	1	3251.22	30748.9	$3p_4-X_8$
0	2931.62	34101.0	$3p_7-X_4$	5	3258.38	30681.4	$3p_2-X_6$, $3p_3-X_7$
1	2945.92	33935.2	$3p_9-X_6$	0	3260.45	30661.8	$3p_4-X_9$
3	2947.56	33916.5	$3p_6-X_1$	3	3274.36	30531.6	$3p_3-X_8$
7	2951.50	33871.2	$3p_5-X_4$	7	3285.86	30424.7	$3s_2-3p_6$
1	2952.83	33855.9	$3p_8-X_5$	3	3318.14	30128.7	$3p_2-X_8$
1	2960.11	33772.7	$3p_6-X_2$	3	3327.81	30041.3	$3p_2-X_9$
5	2975.24	33600.9	$3s_3-3p_4$	0	3373.26	29636.4	$3s_2-3p_5$
5	2979.96	33547.7	$3p_8-X_6$	–	3400.2	29401.4	$3s_2-3p_7$
0	2981.03	33535.7	$3p_9-X_7$	1	3462.68	28871.1	$3s_2-3p_8$
5	2984.45	33497.2	$3s_4-3p_6$	10	3533.03	28296.2	$3s_5-3p_{10}$
2	3007.65	33238.9	$3s_5-3p_7$	8	3631.37	27530.0	$3s_4-3p_{10}$
2	3009.60	33217.4	$3p_4-X_1$	3	3711.2	26938.	$3s_3-3p_{10}$

[1] Shillinger, Akad. Wiss. Wien Sitz-Ber. **118,** 11 (1909).
[2] Foote, Meggers and Mohler, Astrophys. J. **55,** 145 (1922).
[3] Newman, Phil. Mag. **5,** 150 (1928).

possible to classify all but ten of the lines of intensity greater than 1. The lines thus identified are given in Table I. The wave-lengths above 2000A are taken from Newman.

The relative intensities and separations of the lines of the $3s-3p$ group follow closely those found in the spectra of other eight-electron systems, such as Ne_I, A_I, K_{II}, Ca_{III}. This leaves little doubt as to the identification of the lines in this group, with the possible exception of those involving the p_5 level.

The remaining levels originate from the configurations for which the excited electron is in either a $3d$ or a $4s$ orbit. Since these configurations are predicted to have almost identical energies it is in most cases quite impossible to differentiate between the terms arising from them. Consequently all of these levels are designated with an X. It is quite probable that X_1 is the $4s_2$ level and X_3 the $4s_3$ level. $4s_5$ should have a term value about 2000 cm^{-1} greater than these and therefore falls near the position of X_7 which has the proper inner quantum number. Assuming this identification and making this X_7 term and the $3s_5$ term fit a Ritz formula similar to that which

TABLE II. *Term values in Na_{II}.*

Term	J	Value	Term	J	Value
$3s_2$	1	112161.5	$3p_8$	2	83290.3
$3s_3$	0	114642.5	$3p_9$	3	83678.2
$3s_4$	1	115234.5	$3p_{10}$	1	87704.3
$3s_5$	2	116000.0			
			X_1	1	47821.0
$2p$	0	380950.	X_2	1–2	47964.8
			X_3	0	48218.4
$3p_2$	1	80419.9	X_4	1	48655.3
$3p_3$	2	80823.1	X_5	2	49433.2
$3p_4$	1	81041.2	X_6	2	49742.9
$3p_5$	0	82525.1	X_7	2	50142.0
$3p_6$	2	81737.2	X_8	1–2	50291.3
$3p_7$	1	82760.7	X_9	1–2	50377.9

describes the corresponding series in neon the term values given in Table II are obtained. Regardless of the validity of the identification of these $4s$ terms the values can hardly be in error by more than a very few thousand frequency units since the d levels should be nearly hydrogen-like and therefore must have term values in the neighborhood of 48770 cm^{-1}. All of the X terms, part of which are certainly $3d$ terms, fall within 2000 cm^{-1} of this value. These terms fix the ionization potential at 47.0 ± 0.5 volts.

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